

Task Order 1 ATTACHMENT
Regional Methods Proposal for FY2012

TITLE: Improving TMDL and Waste Load Allocation Permit Limits by Determination and Application of New Sediment Diagenesis Input Parameters in Current Water Quality Models

REGIONAL TECHNICAL CONTACT: Mel Parsons, Region 4 SEDS, 980 College Station Road, Athens, GA 30605, 706.202.5092, parsons.mel@epa.gov.

MANAGER'S NAME AND SIGNATURE: John Deatrick

ES&T DIRECTOR'S NAME AND SIGNATURE: Michael Peyton

RSL's NAME: Thomas Baugh. Baugh has deferred to Peyton, per 10/05/10 e-mail from Baugh to SEDS, with concurrence from Dennis Wesolowski in 10/05/2010 e-mail to SEDS.

ORD CONTACT: Jim Harvey

PRINCIPAL INVESTIGATORS/RECIPIENTS: **STREAMS 2 Contract**

ABSTRACT:

States within EPA R4 utilize water quality models, with required data inputs, to manage nutrient pollution of water bodies on their 303(d) lists through the TMDL and Waste Load Allocation Program. One of the processes long known to impact the quality of surface waters is the oxygen demand by and concomitant nutrient release from bottom sediments. Sediment oxygen demand (SOD), due to the mineralization (diagenesis) of organic materials in bottom sediments, can greatly contribute to oxygen declines in water bodies. Because of their importance, SOD and associated sediment nutrient release rates have been included in essentially all modern numerical water quality models (Martin, 2002). R4 currently collects data for these parameters as model inputs through *in-situ* chamber measurements. Although chamber measurements are a reliable and accurate means of determining these rates, the method is very labor intensive and therefore limiting in the number of locations that can be studied in a given time frame for a given water body. A mechanistic model, incorporating sediment diagenesis, that provided links between influxes of organic materials to sediments; physical, biological and chemical processes occurring within the sediments; and consequent sediment oxygen demand and nutrient release, was developed by De Toro et al. (1990). Unfortunately, there are currently no measureable parameters identified that can be utilized to calibrate or verify the diagenesis module. The objectives of this proposed research are to determine supporting parameters that may be utilized in the diagenesis module and to explore means of expanding the spatial sampling capacity for these parameters in a given water body. In particular the use of molybdate to thiomolybdate conversion, as an indicator of anoxia and SOD, will be examined.

BACKGROUND:

Eutrophication and associated impacts on ecosystem services are significant issues for many watersheds in Region 4, including the largest estuarine system in the southeast, the Albemarle-Pamlico watershed in North Carolina and Virginia, containing estuaries on the Federal list of impaired waters under Section 303(d) of the Clean Water Act. Others areas such as Tampa Bay have specific goals set for seagrass restoration and have developed a Nitrogen Consortium to evaluate inputs of nitrogen into Tampa Bay to voluntarily limit those inputs. Both these areas are a focus of a large research program in the EPA Office of Research and Development (ORD) called the Ecosystem Services Research Program (ESRP). Within the ESRP, the Tampa Bay and Albemarle-Pamlico watershed, (and its associated estuaries), are two of five place-based studies across the nation, with an important focus in these locations on issues related to nitrogen management.

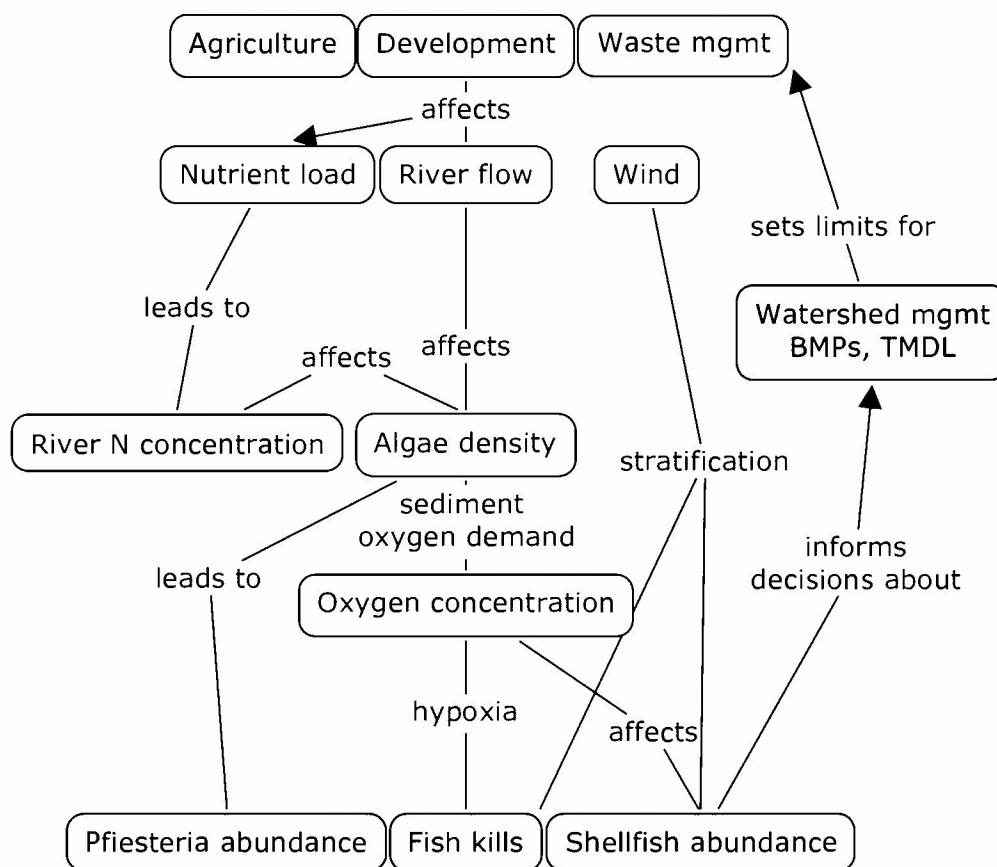


Fig. 1. Conceptual model for nutrient impacts on the Neuse river system (after Shabman, 2005).

A conceptual model for the impacts of human activities in a watershed is shown in Figure 1 for example. Drivers of agriculture, development, and waste management lead to system pressures, including nutrient loading. These pressures affect the state of the system (Figure 1, green boxes), and, in turn, ecological endpoints (shown in blue). Ecosystem services are the endpoints that affect people, and therefore are the aspects of the environment that

people care about. A better understanding and quantification of the state of the system will enable us to better judge the way services provided by this system are impacted by human activity. This improved judgment will in turn inform and improve management decisions in the watershed.

States within EPA R4 utilize water quality models, with required data inputs, to manage nutrient pollution of water bodies on their 303(d) lists through the TMDL and Waste Load Allocation Program. One of the processes long known to impact the quality of surface waters is the oxygen demand by and concomitant nutrient release from the bottom sediments. Sediment oxygen demand (SOD), due to the mineralization (diagenesis) of organic materials in bottom sediments, can greatly contribute to oxygen declines in water bodies. Because of their importance, SOD and associated sediment nutrient release rates have been included in essentially all modern numerical water quality models (Martin, 2002), R4 currently collects data for these parameters as model inputs by *in-situ* chamber measurements (EPA, 2009). Although chamber measurements are a reliable and accurate means of determining these rates, the method is very labor intensive and therefore limiting in the of locations that can be studied in a given time frame for a given water body.

A mechanistic model, incorporating sediment diagenesis which provided links between influxes of organic materials to sediments; physical, biological and chemical processes occurring within sediments; and consequent sediment oxygen demand and nutrient release, was developed by DiToro et al. (1990). This routine is being or has been incorporated into popular water quality models such as QUAL2K (Chapra 2007) and WASP (Wool et al. 2003, Martin 2004), distributed to states by EPA's Watershed and Water Quality Modeling Technical Support Center, and the CE-QUAL-ICM model (Cerco and Cole 1995), distributed by the Corps of Engineers. Unfortunately, there are few measureable parameters identified that can be utilized to calibrate or verify the diagenesis module. Efforts to manage nutrient levels, particularly nitrogen, in Tampa Bay depend on accurate estimates of nutrient inputs, exports, and transformations at the sediment-water interface. This is particularly important in a shallow, well mixed estuary like Tampa Bay, where exchanges between the water column and bottom sediments may contribute significantly to nutrient transformation processes and sediment oxygen demand (Tampa Bay Estuary Program, 2006).

RESEARCH OBJECTIVES:

The objectives of this proposed research are: 1) to determine supporting parameters that may be utilized in the diagenesis module such as light penetration, depth, sediment particle size and composition and chemical measurements that have a high probability of reflecting sediment oxygen demand (SOD) in oxic sediments of Tampa bay and similar environments. These include but are not limited to measurements conducted by DiToro et al. (1990) and the Tampa Bay Estuary Program (2006) such as SOD rates, flux rates for ammonia, total nitrogen (organic and inorganic) and total phosphorus in water from chambers and cores (initial and final concentrations). Bulk sediment analyses should include ammonia, total nitrogen (organic and inorganic) and total phosphorus, aluminum, iron, manganese, and thiomolybdate. DOC, TOC and sulfur may be analyzed if funds are available; and 2) to explore means of calibrating

sediment core SOD measurements to SOD measurements conducted by EPA Region 4 SEDS using SOD chambers (USEPA 2009).

The working hypothesis for the project is that measureable concentrations of reduced metals in sediment and pore water are correlated with sediment oxygen demand and nutrient flux rates.

This research would help Region 4 do its work better through a broader understanding of the biogeochemical processes involved with sediment diagenesis. Since the diagenesis module is or will be included in current water quality models, it has the potential to affect the entire regulated community through improved model outputs for loading predictions and therefore more accurate permit limits for dischargers. This research would greatly improve current water quality models, because the sediment diagenesis component is well founded in theory but lacks measureable inputs for verification and calibration. This work also has utility for water quality submodels for ecosystem services in Tampa Bay that are already under development. Funding for this research would address the need to have leading experts in the field focus directly on establishing essential parameterization inputs for popular water quality models. There are currently no alternative opportunities to address this need. Chamber studies have been at the forefront of SOD/nutrient flux measurements for many years, but there is currently inadequate information available on additional measureable parameters for model input.

More accurate permit limits for dischargers would be extremely beneficial to states and communities with water bodies on the 303(d) list. More accurate permit limits and an improved understanding by Federal and State regulatory agencies concerning the biogeochemical processes in sediment that can contribute to eutrophication in our water bodies will lead to healthier ecosystem with fewer violations of water quality standards and failures to meet designated uses.

Improved understanding, methods, and data sets would provide better inputs to frequently used water quality models, thus allowing EPA and the States to better manage 303(d)-listed water bodies in the Region and Nationally. The proposed work would improve understanding of how human activities affect estuarine ecosystems and the services they provide, which in turn will lead to improved management of these valued systems Region-wide. The diagenesis model would also be applicable to fresh water systems in R4 as well as nationally.

RESEARCH APPROACH:

Field testing and evaluation of potential sampling methods began at SEDS in FY2010. Additional testing of sampling methods and chemical parameters recommended by the Principle Investigators would be coordinated with SEDS and ORD researchers in Tampa Bay and various locations around the Region on a seasonal basis beginning in FY2012. Traditional SOD/nutrient flux projects are already planned for 2012, in conjunction with SEDS's workplan. These projects will also provide information to assess potential methods and parameters for diagenesis and examine and perhaps correlate the range of environmental conditions under which measured variables can be used to estimate the SOD.

In addition, the other research partners would conduct field and model verifications of potential parameters, both independently and collaboratively during SESD's field efforts. Through these efforts, physical and chemical characteristics of sediment and pore water would be identified that could be utilized as model inputs to estimate SOD/nutrient flux rates, in addition to traditional chamber measurements. These additional measurements would not only help delineate variability that isn't currently possible to detect, but would also provide enough data points to be statistically defensible. These measurements could include concentrations of ammonia, nitrate, organic N, thiomolybdate (MoS_4), iron (Fe), manganese (Mn) and hydrogen sulfide (H_2S) in surface and subsurface sediments as well as depth, light penetration, and chlorophyll a. Nitrate, Fe, Mn, and H_2S concentrations are recognized for their importance relating to SOD/nutrient flux (Di Toro 1998, 2001; Murrell et al. 2009; Tampa Bay Estuary Program 2006)) and are scheduled to be included in the WASP diagenesis module.

Accumulation of Mo has been utilized as a geochemical marker of hypoxic bottom water conditions (Adelson et al., 2001; Boothman and Coiro, 2009; Crusius et al., 1996). Concentration of Mo in sediment may be utilized to assess interactions between sediment diagenesis and water column dynamics and their relationship to nitrogen loading from watersheds (Murrell et al, 2009). ORD's National Health and Environmental Effects Research Laboratory (NHEERL), Gulf Ecology Division (GED) and Atlantic Ecology Division (AED), will share information and participate in data analysis and model verification and calibration, based on parameters measured by contractors and SESD.

Laboratory analysis for additional relevant constituents, including nutrients, organic carbon, and selected metals would be conducted by the R4 SESD Laboratory and contractor. Parameters would include: SOD rates, flux rates for ammonia, total nitrogen (organic and inorganic) and total phosphorus in water from chambers and cores (initial and final concentrations). Bulk sediment analyses should include ammonia, total nitrogen (organic and inorganic) and total phosphorus, aluminum, iron, manganese, and thiomolybdate. DOC, TOC and sulfur may be analyzed if funds are available to determine "What is the effect of altering boundary conditions- effects of light, redox, and how can this relate to SOD and TMDLs?" Statistical analysis will be conducted by ESRP and SESD researchers to determine **what drives SOD most strongly and under what conditions**.

Model estimates of SOD/nutrient flux, based on the parameterized diagenesis module, would be generated by the principal investigators. SESD and ESRP researchers would then statistically compare the model estimates to chamber measurements of SOD/nutrient flux.

RESEARCH PRODUCTS:

Quarterly reports that summarize field activities, data obtained, and initial data analyses shall be submitted. A final report by the collaborators detailing the findings and recommendations of this research would be issued at the culmination of the project. The conclusions of this report could be incorporated into the sediment diagenesis component of various water quality models. The report would also form the basis of one or more peer-reviewed journal article or similar product.

PROJECT MANAGEMENT:

SESD will work with contractor and ESRP researchers in development of the Research workplan, Quality Assurance Project Plan, and will participate as co-author on reports and publications. SESD will meet quarterly (at a minimum) with ORD contact and ESRP researchers to review progress.

COLLABORATORS AND ROLES:

Mel Parsons- Regional Contact, R4 SESD representative, 706-202-5092, parsons.mel@epa.gov Biologist in the Ecological Assessment Branch of the Science and Ecosystem Support Division (SESD) Athens, GA. Lead for SOD and Nutrient flux measurements in R4; Liaison to SESD's in-house chemists.

Jim Harvey- ORD Sponsor and Project Officer (COTR) 850-934-9237, harvey.jim@epa.gov Research Biologist in the Ecosystems Assessment Branch of the Gulf Ecology Division, National Health and Environmental Effects Research Laboratory. ORD ESRP Tampa research task member and ORD Contact, responsible for contract administration.

Marc Russell-Research Ecologist and Lead for the ORD ESRP Tampa Bay Demonstration Project. 850-934-9344, russell.marc@epa.gov Ecosystems Assessment Branch of the Gulf Ecology Division, National Health and Environmental Effects Research Laboratory.

Richard Devereux- Research Microbiologist-microbial transformation of sulfur and related biogeochemistry, 850-934-9346, devereux.richard@epa.gov, Acting Branch Chief, Ecosystem Assessment Branch, Gulf Ecology Division, National Health and Environmental Effects Research Laboratory.

John E. Rogers- Research Microbiologist, 850-934-9326, rogers.johne@epa.gov Developer of Systems Dynamic Model for Tampa Bay seagrass growth. Gulf Ecology Division, National Health and Environmental Effects Research Laboratory.

REFERENCES:

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ORDER FOR SUPPLIES OR SERVICES

PAGE OF PAGES

1 13

IMPORTANT: Mark all packages and papers with contract and/or order numbers.

1. DATE OF ORDER 06/06/2012		2. CONTRACT NO. (If any) EP-C-11-037		6. SHIP TO: a. NAME OF CONSIGNEE NHEERL - GED	
3. ORDER NO. 0001		4. REQUISITION/REFERENCE NO. PR-ORD-12-00287			
5. ISSUING OFFICE (Address correspondence to) CPOD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268				b. STREET ADDRESS US Environmental Protection Agency National Health and Environmental Effects Research Lab 1 Sabine Island Drive	
				c. CITY Gulf Breeze	e. ZIP CODE 32561
7. TO: (b)(4)				f. SHIP VIA	
a. NAME OF CONTRACTOR TETRA TECH EM, INC.				8. TYPE OF ORDER	
b. COMPANY NAME				<input type="checkbox"/> a. PURCHASE <input checked="" type="checkbox"/> b. DELIVERY REFERENCE YOUR: _____ Please furnish the following on the terms and conditions specified on both sides of this order and on the attached sheet, if any, including delivery as indicated.	
c. STREET ADDRESS 1881 CAMPUS COMMONS DRIVE SUITE 200 (b)(4)				Except for billing instructions on the reverse, this delivery order is subject to instructions contained on this side only of this form and is issued subject to the terms and conditions of the above-numbered contract.	
d. CITY RESTON		e. STATE VA	f. ZIP CODE 201911519		
9. ACCOUNTING AND APPROPRIATION DATA See Schedule				10. REQUISITIONING OFFICE CPOD	

11. BUSINESS CLASSIFICATION (Check appropriate box(es))				12. F.O.B. POINT Destination	
<input type="checkbox"/> a. SMALL <input checked="" type="checkbox"/> b. OTHER THAN SMALL <input type="checkbox"/> c. DISADVANTAGED <input type="checkbox"/> d. WOMEN-OWNED <input type="checkbox"/> e. HUBZone <input type="checkbox"/> f. SERVICE-DISABLED VETERAN-OWNED <input type="checkbox"/> g. WOMEN-OWNED SMALL BUSINESS (WOSB) ELIGIBLE UNDER THE WOMEN-OWNED SMALL BUSINESS PROGRAM <input type="checkbox"/> h. ECONOMICALLY DISADVANTAGED WOMEN-OWNED SMALL BUSINESS (EDWOSB)					
13. PLACE OF		14. GOVERNMENT B/L NO.		15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date) 30 Days After Award	
a. INSPECTION Destination	b. ACCEPTANCE Destination				

17. SCHEDULE (See reverse for Rejections)

ITEM NO. (a)	SUPPLIES OR SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
	DUNS Number: (b)(4) TOPO: Jim Harvey Continued ...					

SEE BILLING INSTRUCTIONS ON REVERSE	18. SHIPPING POINT		19. GROSS SHIPPING WEIGHT		20. INVOICE NO.		17(f) TOTAL (Cont. pages)
	21. MAIL INVOICE TO:						
	a. NAME RTP Finance Center						\$0.00
	b. STREET ADDRESS (or P.O. Box) US Environmental Protection Agency RTP-Finance Center Mail Drop D143-02 109 TW Alexander Drive						\$99,333.77
c. CITY Durham		d. STATE NC	e. ZIP CODE 27711				17(i) GRAND TOTAL

22. UNITED STATES OF AMERICA BY (Signature)

23. NAME (Typed)
Camille W. Davis
TITLE: CONTRACTING/ORDERING OFFICER

ORDER FOR SUPPLIES OR SERVICES

SCHEDULE - CONTINUATION

PAGE NO
2

IMPORTANT: Mark all packages and papers with contract and/or order numbers.

DATE OF ORDER 06/06/2012	CONTRACT NO. EP-C-11-037	ORDER NO. 0001
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ITEM NO. (a)	SUPPLIES/SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
0001	<p>Admin Office: CPOD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268</p> <p>Accounting Info: 11-12-C-261E000-404FB2APW-2532-12261EC007-00 1 BFY: 11 EFY: 12 Fund: C Budget Org: 261E000 Program (PRC): 404FB2APW Budget (BOC): 2532 DCN - Line ID: 12261EC007-001 Period of Performance: 06/06/2012 to 11/15/2013</p> <p>Regional Methods Program Project Number 11RMP-05, Improving TMDL and Waste Load Allocation Permit Limits by Determination and Application of New Sediment Diagenesis Input Parameters in Current Water Quality Models-1st Action</p> <p>The obligated amount of award: \$60,000.00. The total for this award is</p>					

TOTAL CARRIED FORWARD TO 1ST PAGE (ITEM 17(H))

\$0.00

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT				1. CONTRACT ID CODE		PAGE OF PAGES	
						1 2	
2. AMENDMENT/MODIFICATION NO.		3. EFFECTIVE DATE		4. REQUISITION/PURCHASE REQ. NO.		5. PROJECT NO. (If applicable)	
001		11/29/2012		PR-ORD-13-00214			
6. ISSUED BY		CODE		7. ADMINISTERED BY (If other than Item 6)		CODE	
CPOD		CPOD		CPOD		CPOD	
CPOD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268				CPOD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268			
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)				(x) 9A. AMENDMENT OF SOLICITATION NO.			
TETRA TECH EM, INC. Attn: (b)(4) 1881 CAMPUS COMMONS DRIVE SUITE 200 (b)(4) RESTON VA 201911519				9B. DATED (SEE ITEM 11)			
				x 10A. MODIFICATION OF CONTRACT/ORDER NO. EP-C-11-037 0001			
				10B. DATED (SEE ITEM 13) 06/06/2012			
CODE		(b)(4)		FACILITY CODE			
11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS							
<input type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.							
12. ACCOUNTING AND APPROPRIATION DATA (If required)				Net Increase:		\$27,190.00	
See Schedule							
13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.							
CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.						
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).						
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:						
X	D. OTHER (Specify type of modification and authority) Limitation of Funds Notice						
E. IMPORTANT: Contractor <input checked="" type="checkbox"/> is not, <input type="checkbox"/> is required to sign this document and return _____ copies to the issuing office.							
14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)							
DUNS Number: (b)(4) Improving TMDL and Waste Load Allocation Permit Limits by Determination and Application of New Sediment Diagenesis Input Parameters in Current Water Quality Models TOPO: Jim Harvey LIST OF CHANGES: Reason for Modification : Funding Only Action Obligated Amount for this Modification: \$27,190.00 New Total Obligated Amount for this Award: \$87,190.00 Incremental Funded Amount changed From \$60,000.00 To \$87,190.00 Continued ...							
Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.							
15A. NAME AND TITLE OF SIGNER (Type or print)				16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)			
				Camille W. Davis			
15B. CONTRACTOR/OFFEROR		15C. DATE SIGNED		16B. UNITED STATES OF AMERICA		16C. DATE SIGNED	
(Signature of person authorized to sign)				(Signature of Contracting Officer)		11/29/2012	

CONTINUATION SHEET

REFERENCE NO. OF DOCUMENT BEING CONTINUED

EP-C-11-037/0001/001

PAGE OF

2

2

NAME OF OFFEROR OR CONTRACTOR

TETRA TECH EM, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	<p>CHANGES FOR LINE ITEM NUMBER: 1</p> <p>Obligated Amount for this modification: \$27,190.00</p> <p>NEW ACCOUNTING CODE ADDED:</p> <p>Account code:</p> <p>12-13-C-261E000-301FK8XPV-2532-26A6F-13261AC049-001</p> <p>Beginning FiscalYear 12</p> <p>Ending Fiscal Year 13</p> <p>Fund (Appropriation) C</p> <p>Budget Organization 261E000</p> <p>Quantity: 0</p> <p>Amount: \$27,190.00</p> <p>Funding break-outs for this Incremental Funding is as follows:</p> <p>Cost: (b)(4)</p> <p>Fee:</p> <p>TOTAL: \$27,190.00</p> <p>Delivery: 30 Days After Award</p> <p>Delivery Location Code: NHEERL - GED</p> <p>NHEERL - GED</p> <p>US Environmental Protection Agency</p> <p>National Health and</p> <p>Environmental Effects Research Lab</p> <p>1 Sabine Island Drive</p> <p>Gulf Breeze FL 32561 USA</p> <p>Payment:</p> <p>RTP Finance Center</p> <p>US Environmental Protection Agency</p> <p>RTP-Finance Center</p> <p>Mail Drop D143-02</p> <p>109 TW Alexander Drive</p> <p>Durham NC 27711</p> <p>FOB: Destination</p> <p>Period of Performance: 06/06/2012 to 11/15/2013</p>				

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT				1. CONTRACT ID CODE		PAGE OF PAGES	
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2. AMENDMENT/MODIFICATION NO.		3. EFFECTIVE DATE		4. REQUISITION/PURCHASE REQ. NO.		5. PROJECT NO. (If applicable)	
002		01/23/2013		PR-ORD-13-00738			
6. ISSUED BY		CODE		7. ADMINISTERED BY (If other than Item 6)		CODE	
CP0D		CP0D		CP0D		CP0D	
CP0D US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268				CP0D US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268			
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)				(x) 9A. AMENDMENT OF SOLICITATION NO.			
TETRA TECH EM, INC. Attn: (b)(4) 1881 CAMPUS COMMONS DRIVE SUITE 200 (b)(4) RESTON VA 201911519				9B. DATED (SEE ITEM 11)			
				x 10A. MODIFICATION OF CONTRACT/ORDER NO. EP-C-11-037 0001			
				10B. DATED (SEE ITEM 13) 06/06/2012			
CODE (b)(4)		FACILITY CODE					
11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS							
<input type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.							
12. ACCOUNTING AND APPROPRIATION DATA (If required)				Net Increase:		\$6,600.00	
See Schedule							
13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.							
CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.						
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).						
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:						
X	D. OTHER (Specify type of modification and authority) Limitation of Funds Notice						
E. IMPORTANT: Contractor <input checked="" type="checkbox"/> is not, <input type="checkbox"/> is required to sign this document and return _____ copies to the issuing office.							
14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)							
DUNS Number: (b)(4)							
The purpose of this modification is to add incremental funding to the task order.							
TOPO: Jim Harvey							
LIST OF CHANGES:							
Reason for Modification : Funding Only Action							
Obligated Amount for this Modification: \$6,600.00							
New Total Obligated Amount for this Award: \$93,790.00							
Incremental Funded Amount changed From \$87,190.00 To \$93,790.00							
CHANGES FOR LINE ITEM NUMBER: 1							
Continued ...							
Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.							
15A. NAME AND TITLE OF SIGNER (Type or print)				16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)			
				Camille W. Davis			
15B. CONTRACTOR/OFFEROR		15C. DATE SIGNED		16B. UNITED STATES OF AMERICA		16C. DATE SIGNED	
(Signature of person authorized to sign)				(Signature of Contracting Officer)		01/23/2013	

CONTINUATION SHEET

REFERENCE NO. OF DOCUMENT BEING CONTINUED

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NAME OF OFFEROR OR CONTRACTOR

TETRA TECH EM, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	<p>Obligated Amount for this modification: \$6,600.00 Incremental Funded Amount changed from \$87,190.00 to \$93,790.00</p> <p>NEW ACCOUNTING CODE ADDED: Account code: 12-13-C-261E000-301FK8XPW-2532-26A6F-13261EC069-001 Beginning FiscalYear 12 Ending Fiscal Year 13 Fund (Appropriation) C Budget Organization 261E000 Quantity: 0 Amount: \$6,600.00</p> <p>The break-out for this incremental funding is as follows: Cost: \$(b)(4) Fee: \$ TOTAL: \$6,600.00 Payment: RTP Finance Center US Environmental Protection Agency RTP-Finance Center Mail Drop D143-02 109 TW Alexander Drive Durham NC 27711 FOB: Destination Period of Performance: 06/06/2012 to 11/15/2013</p>				

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT			1. CONTRACT ID CODE		PAGE OF PAGES 1 2									
2. AMENDMENT/MODIFICATION NO. 003		3. EFFECTIVE DATE 01/25/2013		4. REQUISITION/PURCHASE REQ. NO. PR-ORD-13-00761		5. PROJECT NO. (If applicable)								
6. ISSUED BY CP US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268		CODE CP		7. ADMINISTERED BY (If other than Item 6) CP US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268		CODE CP								
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code) TETRA TECH EM, INC. Attn: (b)(4) 1881 CAMPUS COMMONS DRIVE SUITE 200 (b)(4) RESTON VA 201911519 CODE (b)(4) FACILITY CODE				(x) 9A. AMENDMENT OF SOLICITATION NO.										
				9B. DATED (SEE ITEM 11)										
				x 10A. MODIFICATION OF CONTRACT/ORDER NO. EP-C-11-037 0001										
				10B. DATED (SEE ITEM 13) 06/06/2012										
11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS														
<input type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers <input type="checkbox"/> is extended, <input type="checkbox"/> is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.														
12. ACCOUNTING AND APPROPRIATION DATA (If required) See Schedule Net Increase: \$5,543.77														
13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.														
<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:10%;">CHECK ONE</td> <td>A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.</td> </tr> <tr> <td></td> <td>B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).</td> </tr> <tr> <td></td> <td>C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:</td> </tr> <tr> <td>X</td> <td>D. OTHER (Specify type of modification and authority) Limitation of Funds Notice</td> </tr> </table>							CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.		B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).		C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:	X	D. OTHER (Specify type of modification and authority) Limitation of Funds Notice
CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.													
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).													
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:													
X	D. OTHER (Specify type of modification and authority) Limitation of Funds Notice													
E. IMPORTANT: Contractor <input checked="" type="checkbox"/> is not, <input type="checkbox"/> is required to sign this document and return _____ copies to the issuing office.														
14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.) DUNS Number: (b)(4) The purpose of this modification is to add incremental funding to fully fund the task order. TOPO: Jim Harvey LIST OF CHANGES: Reason for Modification : Funding Only Action Obligated Amount for this Modification: \$5,543.77 New Total Obligated Amount for this Award: \$99,333.77 Incremental Funded Amount changed from \$93,790.00 to \$99,333.77 Continued ... Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.														
15A. NAME AND TITLE OF SIGNER (Type or print)				16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)										
				Camille W. Davis										
15B. CONTRACTOR/OFFEROR		15C. DATE SIGNED		16B. UNITED STATES OF AMERICA		16C. DATE SIGNED								
(Signature of person authorized to sign)				(Signature of Contracting Officer)		01/25/2013								

CONTINUATION SHEET

REFERENCE NO. OF DOCUMENT BEING CONTINUED

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NAME OF OFFEROR OR CONTRACTOR

TETRA TECH EM, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	<p>CHANGES FOR LINE ITEM NUMBER: 1</p> <p>Obligated Amount for this modification: \$5,543.77</p> <p>Incremental Funded Amount changed from \$93,790.00 to \$99,333.77</p> <p>NEW ACCOUNTING CODE ADDED:</p> <p>Account code:</p> <p>12-13-C-261E000-301FK8XPV-2532-26A6F-13261EC068-001</p> <p>Beginning FiscalYear 12</p> <p>Ending Fiscal Year 13</p> <p>Fund (Appropriation) C</p> <p>Budget Organization 261E000</p> <p>Quantity: 0</p> <p>Amount: \$5,543.77</p> <p>The incremental funding break-out is as follows:</p> <p>Cost: (b)(4)</p> <p>Fee:</p> <p>TOTAL: \$5,543.77</p> <p>Payment:</p> <p>RTP Finance Center</p> <p>US Environmental Protection Agency</p> <p>RTP-Finance Center</p> <p>Mail Drop D143-02</p> <p>109 TW Alexander Drive</p> <p>Durham NC 27711</p> <p>FOB: Destination</p> <p>Period of Performance: 06/06/2012 to 11/15/2013</p>				

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT			1. CONTRACT ID CODE		PAGE OF PAGES 1 2		
2. AMENDMENT/MODIFICATION NO. 004		3. EFFECTIVE DATE 10/29/2013		4. REQUISITION/PURCHASE REQ. NO. PR-ORD-13-00761		5. PROJECT NO. (If applicable)	
6. ISSUED BY CP OD		CODE CP OD		7. ADMINISTERED BY (If other than Item 6)		CODE	
CP OD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: NWD Cincinnati OH 45268							
8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code) TETRA TECH EM, INC. Attn: (b)(4) 1881 CAMPUS COMMONS DRIVE SUITE 200 (b)(4) RESTON VA 201911519				(x)		9A. AMENDMENT OF SOLICITATION NO.	
						9B. DATED (SEE ITEM 11)	
				x		10A. MODIFICATION OF CONTRACT/ORDER NO. EP-C-11-037 0001	
						10B. DATED (SEE ITEM 13) 06/06/2012	
CODE (b)(4)		FACILITY CODE					

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended. ☐ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

See Schedule

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
X	D. OTHER (Specify type of modification and authority) Mutual Agreement between the Parties and Tetra Tech's e-mail dated 10/24/13

E. IMPORTANT: Contractor ☒ is not, ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

DUNS Number: (b)(4)

The purpose of this modification is to extend the period of performance until February 28, 2014 due to the government shutdown. This is a No Cost extension.

TOPO: Jim Harvey

LIST OF CHANGES:

Reason for Modification: Extend Period of Performance

Period of Performance End Date changed

From: November 15, 2013

To: February 18, 2014

Continued ...

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) Camille W. Davis	
15B. CONTRACTOR/OFFEROR (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA (Signature of Contracting Officer)	16C. DATE SIGNED

CONTINUATION SHEET

REFERENCE NO. OF DOCUMENT BEING CONTINUED

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NAME OF OFFEROR OR CONTRACTOR

TETRA TECH EM, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	<p>This is a No Cost Extension Delivery: 30 Days After Award Delivery Location Code: NHEERL - GED NHEERL - GED US Environmental Protection Agency National Health and Environmental Effects Research Lab 1 Sabine Island Drive Gulf Breeze FL 32561 USA</p> <p>Payment: RTP Finance Center US Environmental Protection Agency RTP-Finance Center Mail Drop D143-02 109 TW Alexander Drive Durham NC 27711</p> <p>FOB: Destination Period of Performance: 06/06/2012 to 02/28/2014</p>				

CONTINUATION SHEET

REFERENCE NO. OF DOCUMENT BEING CONTINUED

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NAME OF OFFEROR OR CONTRACTOR

TETRA TECH EM, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
	<p>From: \$99,333.77 To: \$99,131.64</p> <p>CHANGES FOR LINE ITEM NUMBER: 1 Obligated Amount for this modification: -\$202.13 Incremental Funded Amount changed from \$99,333.77 to \$99,131.64</p> <p>CHANGES FOR ACCOUNTING CODE: 12-13-C-261E000-301FK8XPV-2532-26A6F-13261EC068-001 Amount changed from \$5,543.77 to \$5,341.64</p> <p>Fundig break-out is hereby changed to read as follows:</p> <p>Cost: (b)(4) Fee: Total: \$99,131.64</p> <p>Delivery: 30 Days After Award Delivery Location Code: NHEERL - GED NHEERL - GED US Environmental Protection Agency National Health and Environmental Effects Research Lab 1 Sabine Island Drive Gulf Breeze FL 32561 USA</p> <p>Payment: RTP Finance Center US Environmental Protection Agency RTP-Finance Center Mail Drop D143-02 109 TW Alexander Drive Durham NC 27711</p> <p>FOB: Destination Period of Performance: 06/06/2012 to 02/28/2014</p>				